Searches for Leptoquarks with the DØ Detector at the TeVatron

T. Christiansen
LMU München, Am Coulombwall 1, D-85748 Garching, Germany

October 15, 2002

Poster Presentation & Short Communication in Plenary Session of
Frontier Science, Frascati, Italy, Oct. 6-11, 2002

The existence of leptoquarks (LQ), color-triplets of bosons with lepton and quark quantum numbers, is predicted by different theories beyond the Standard Model. This article summarizes the DØ Run-I searches for the three different LQ generations in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV and presents ongoing studies at Run II.

Limits on proton decays, on lepton flavor violation and on flavor-changing neutral currents lead to the assumption that there would be three different generations of leptoquarks, each one of them only interacting within one lepton and quark family. Figure 1 shows Feynman graphs of the dominant production processes in $p\bar{p}$ collisions.

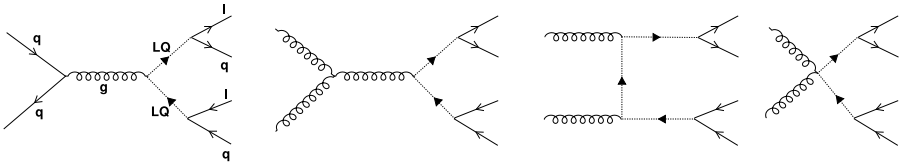

Figure 1: Leading-order diagrams for leptoquark pair production.

Using about 100 pb^{-1} of $p\bar{p}$ collision data with a center-of-mass energy of $\sqrt{s} = 1.8$ GeV recorded during Run I with the DØ detector, no evidence for the existence of leptoquarks was found. The results on the leptoquark searches were combined to 95% confidence limits on the LQ-pair production cross section as a function of the mass m_{LQ} for the different models and leptoquark generations. The lower limits for masses of 1$^{\text{st}}$-generation scalar leptoquarks are 225 GeV, 204 GeV and 79 GeV, assuming a branching fraction to charged leptons of $\beta = BF(LQ \to l^{\pm}q) = 1$, 1/2 and 0, respectively.[1] The corresponding limits for the 2$^{\text{nd}}$-generation scalar LQ masses are determined to 200 GeV, 180 GeV

and 79 GeV.[2] For 3$^{\rm rd}$-generation LQ masses comparable to m_{top}, the decay $LQ_3 \to t + l$ is suppressed or even forbidden. Studies of the $\nu b \bar{\nu} \bar{b}$ channel yield a lower mass limit of 94 GeV for scalar 3$^{\rm rd}$-generation leptoquarks and $\beta = 0$.[3]

If both leptoquarks decay into an electron and a quark, two electrons and two jets can be reconstructed. The left diagram in figure 2 shows the di-electron mass of $eejj$ Run-II candidates collected between November 2001 and May 2002 with $\sqrt{s} \approx 2$ GeV. These 18 events, equivalent to an integrated luminosity of about 8.8 pb^{-1}, are compatible with background (15 ± 5 events expected) which is dominated by Drell-Yan Z production. Comparing the limits on the cross section for different masses m_{LQ} to NLO calculations for scalar leptoquarks, the lower limit on the mass of 1$^{\rm st}$-generation leptoquarks is 113 GeV.[4] This is compatible with earlier results from Run I and reflects the lower integrated luminosity.

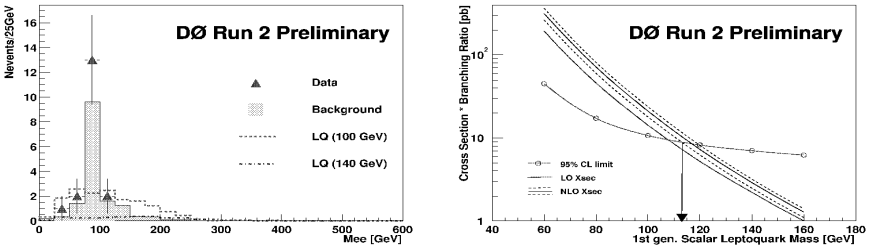

Figure 2: Search for 1$^{\rm st}$-generation leptoquarks at Run II. Left: Di-electron invariant mass of $eejj$ candidate events. Right: LQ-mass dependent limits on the cross section for scalar LQ pairs assuming 100% branching fraction to charged leptons $BF(LQ \to eq) = 1$.[4]

Taking advantage of the increased collision energy and luminosity of the TeVatron for Run II, DØ will be able to extend its searches for leptoquarks to so far inaccessible leptoquark masses. Especially for the second generation, the search for leptoquark pair production will greatly benefit from the upgraded muon spectrometer, the central tracking system with the newly installed magnetic solenoid and the new trigger system.

References

[1] The DØ Collab., V.M. Abazov et al., Phys. Rev. Lett. **64**, 092004 (2001).

[2] The DØ Collab., B. Abbott et al., Phys. Rev. Lett. **84**, 222 (2000).

[3] The DØ Collab., B. Abbott et al., Phys. Rev. Lett. **81**, 38 (1998).

[4] M. Narain for the DØ Collaboration, *Results from the DØ Experiment at the Tevatron*, ICHEP (2002)